A Platform of Serious Video Games Co-built for the General Interest

Pr.Bertrand Laforge[1,2], Thomas Planques[2], Florian Delcourt[2] and Fanny Barnabé[3]
[1]Laboratoire de physique nucléaire et des hautes énergies, Sorbonne Université, IN2P3, Paris, France
[2]Ikigai – Games for citizens non-profit organization, Paris, France
[3]CRIDS/NADI, University of Namur, Namur, Belgium

laforge@lpnhe.in2p3.fr
contact@ikigai.games
formation.animation@ikigai.games
fanny.barnabe@unamur.be

Abstract: In a context where training takes place both in initial courses and in lifelong continuing education, the use of games offers a way of promoting effective and sustainable learning: by its very nature, this medium is an open work in which players can become involved and give meaning to their learning. Ikigai - Games for Citizens offers a unique ecosystem for creating serious, expert video games and offering them free of charge to people who want to learn while having fun, as well as producing a set of learning-related data that can be used for research and customizing training courses. By bringing together universities, Grandes Ecoles, research laboratories, associations, and institutions, Ikigai is a collaborative consortium of general interest, implementing the co-construction of videogame services between scientific experts, video game professionals and educational engineers. Together, they are producing a centralized platform of serious games and associated services that can be used by teachers at a moderate cost by pooling resources: the building blocks of each game can be reused in other games developed. The consortium is committed to general interest and popular education by making the games available free of charge to members and the general public. The decentralized infrastructure set up by Ikigai, which respects privacy by design, means that game usage data can now be collected on a national scale, but conceptually it could extend much further. The data collected in compliance with the RGPD will eventually be used to draw up enriched user profiles to offer personalized courses, teaching recommendations and progress monitoring as close as possible to the learner, using AI in particular. Ikigai is also heavily involved in the construction of new digital standards in education, which are needed to ensure the interoperability of data for lifelong monitoring of learners. But also, for the digital education ecosystem, to guarantee a sovereign, efficient, coherent, and sustainable cloud on a European scale .

Keywords: Video Games, Serious Games, Training, Learning Analytics, Artificial Intelligence

1. Introduction

Gaming attracts a wide and varied audience, with a diversity of activities ranging from card games to video games, board games and role-playing games. The video game itself is quite polymorphous in its use, with a variety of media ranging from smartphones to computers and home or mobile games consoles. One of the great strengths of this medium lies in the commitment it allows its audiences to make (Brown, 2004), like an open work (Eco, 1962) that allows players to give a personal and/or shared playful meaning (Genvo, 2008).

Furthermore, although scientific evidence has long been accumulating to show that games are a useful medium for diversifying learning methods and engaging learners (Sanchez, 2020; Sauvé *et al.*, 2007), producing and distributing them is rarely an easy task for educational establishments wishing to develop learning games (a term we prefer to serious games, as the game activity is always serious for the player who invests in it, but it is the consequences of the game that are not, and they enable learning that values trial and error and the correction of mistakes), whether in terms of the resources and skills to be deployed in creating them or in distributing them to the target audience.

Another obstacle identified is the difficulty experienced by teachers in implementing turnkey video games whose content they cannot modify to suit their teaching needs.

This article presents the rational elements that led to the establishment of a shared national eco-system to meet the needs and obstacles identified in the production of games for learning in the context of initial or continuing training, as well as feedback on the practical implementation of the ikigai.games platform built since 2018 across France.

This unprecedented structure incorporates a powerful system for the distributed collection of game usage data, with the aim of fueling research that will enable the development of new edutainment approaches and more detailed analyses of the impact of games on learning. Using artificial intelligence in particular, this research could also lead to the development of new tools aimed at offering end-users play-based solutions and personalised training courses in line with their profile.

2. Challenges of a Video Games Platform Based on Learning Analytics for Education

While the vast majority of French citizens are in favour of video games as a medium, they are relatively rare in initial and continuing education. However, it has demonstrated real potential for engaging people in learning and discovering new knowledge. Even more, when it does exist, it rarely provides personalised activities that meet the specific needs of each student.

2.1 Video Game Audiences in France

Video games are a particularly well-established medium in people's media landscape, as revealed each year by the survey "Les Français et le Jeu Vidéo" (SELL, 2023). Video games are even considered to be one of the main cultural activities of the French, and even their favourite digital leisure activity.

Nearly 72% of French people declare that they play video games at least occasionally, and this proportion spans a wide range of generations (SELL, 2023), clearly demonstrating that video gaming is by no means an activity confined to children and young adults. Nearly half of all gamers say they play video games at least once a week - over 21 million people in France (SELL, 2023). Video games, in all their diversity, are an interesting medium to use to reach a wide range of audiences.

At the same time, this passion for the medium becomes a constraint that needs to be taken into account when producing video games for education: gamers have expectations linked to their own video game culture, shaped mainly by the video game market. The production of video games with a learning or training objective will therefore have to conform to these expectations in order to engage its audiences, at the risk of breaking the magic circle of the game (Huizinga, 1938).

2.2 Practical Benefits of Video Game in Education

As far as its audiences are concerned, video games are a new medium that has yet to be fully exploited in the context of training, compared with media that are considered to be older: the written word (books, magazines, articles, etc.), audio and video. While the latter bring sound and moving images to written texts and images, video games offer a range of additional tools that can be used for learning: interactivity, immersion, modelling, multiplayer, personalisation, artificial intelligence, reticularity and even virtual, augmented or even diminished reality. Video games sometimes allow for a "reflexive, distanced and 'second-degree' playful attitude" (Barnabé et al, 2018) enabling meta-reflexivity on the playful practice in progress.

Taking Gee's (2003) Learning Principles as a starting point, three particular points that we felt had not yet been worked on drew our particular attention in the design of the games built as part of the development of the ikigai platform. These are: the game's ability to manipulate simulations of complex systems on scales of time and space that are not accessible in the real world, the ability of the video game environment to immerse the learner in a representation linked to the mental schemas that we want students to learn, and finally, the ability of a game mechanic to directly support the intended learning (procedural rhetoric according to Bogost (2008)).

All these elements can be complex to put in place, but they contribute to the popularity of video games. They are also particularly useful in a learning and training context.

2.3 Research Into the use of Video Game in Education

The use of games in education is a subject of research in its own right (Sanchez, 2020), providing an increasingly rich analysis of the contributions of gamification to pedagogy and enabling new, more effective learning strategies to be envisaged (Bayeck, 2020). Although gamification is a marginal medium, particularly when compared with the entertainment games market, it has long been used in learning contexts (Sauvé *et al*, 2007) because, by its very nature, gamification enables a number of processes to be put in place that have to do with the objectives of the educator (Gee, 2003): transferring and analysing information, learning by making mistakes, manipulating things that cannot be manipulated, visualising systems on scales that are invisible in reality, or constructing mental representations based on concrete representations linked to the theoretical concepts being taught. Accompanied by a reflective debriefing with the teacher (Sanchez, 2023), the game proves to be particularly effective for anchoring knowledge and know-how and for the cognitive remediation sometimes necessary to correct misconceptions.

As regards video games specifically, scientific studies have also demonstrated their impact on three main sources of motivation as defined by Sauvé and Viau (2002), namely "[...] the effort or energy that the person is prepared to put into accomplishing a given learning task":

- the feeling of competence as defined by Bandura (2009): "The individual's perception of his or her ability to organise and carry out the course of action required to produce the desired results",
- the feeling of controllability defined by Wigfield and Wentzel (2007) as "Perception of autonomy over certain aspects of learning",
- and the perception of value defined by Viau (1999).

The importance of narrative in video games is also revealed in the learners' involvement in the game and in learning (Maldonado, 2023).

By virtue of its medium, the video game is also a medium that makes it easy to collect usage data, the analysis of which, possibly coupled with other approaches such as experimental cognitive psychology or group sociology, should make it possible to go much further than the state of the art in terms of personalising content and supporting students, well beyond facilitating evaluation of its use and its impact on learning (see part 5).

3. Obstacles to the Development of Games in Education

However, there are many obstacles to the production of games, particularly video games, dedicated to learning. One of the first, if not the most frequently cited by education actors, is the high cost inherent in this type of project. Far from the hundreds of millions of euros required to produce blockbuster video games, the sums typically in the region of €50,000 to €200,000 needed to develop a modest educational video game that meets video game quality standards in terms of game mechanics, graphics and affordance are a major difficulty in developing this type of project and, above all, in producing enough of them to cover the needs of the various disciplines and levels. As a result, such projects are often out of the reach of a single school, which cannot invest so much money in a project of this type without any guarantee of its usability over time, its educational relevance, and the assurance that it will be able to evolve in the future to keep pace with changes in content.

Although some experiments are being carried out on an exploratory basis, the economic equation is that the widespread use of this teaching tool is only possible by acting collectively on the scale of all those involved in education by agreeing to share the tools developed. At present, the conditions under which such a tool is produced by a school are a source of problems.

Often produced as a service, the games produced are then delivered as is by the developer, who is often too weak economically to ensure their maintainability over time or even their possible evolution when it comes, for example, to adding educational customisation algorithms. It is therefore up to the client to maintain and subsequently develop the game, which is rarely done in practice and leads to the obsolescence of previously available games. However, in addition to maintaining use, the school is often interested in upgrading the game, which can be of several kinds, from adding content to new functions. Maintaining a game in relation to the different operating systems that support it already requires a continuous updating of the product, which schools are struggling to guarantee.

Another difficulty is the relative confidentiality of the games produced once they are ready to be distributed to the public. It's not uncommon for a game developed by a university to appear on a dedicated page of the institution's website and then gradually fall into oblivion, with no response several months after its release. What's more, it is quite rare for this type of project to be used outside the institution that produced it, despite the fact that there are common audiences elsewhere, and sometimes even in circles of distribution completely related to that of initial or continuing education: mediation, communication, entertainment, etc. In short, the substantial investment made often struggles to pay off due to a lack of users.

Finally, the last point highlighted in this review is that the games produced are of very uneven quality, often failing to match the digital literacy of the target audiences. As we saw in part 2, there are many different audiences for video games, but they are also used to the quality of commercial video game productions. To win over these audiences, it is therefore important to offer productions of a quality that matches their expectations, of a quality that corresponds to the video game market. A serious video game that does not meet these standards will never be perceived by its target audience as a truly entertaining tool.

4. Ikigai, a Collaborative Ecosystem to Bring Video Games Into Education and Move Beyond the Demo Effect

In 2017, the Ikigai project was born within Sorbonne University. Its aim? To create a high-quality range of video games with specific educational objectives. But it was in 2020, following the identification of the many obstacles to the production of games in many universities, that the Ikigai project changed scale and became a national consortium structured as a non-profit association. The consortium's aim is to make gamification available to teaching, popular education, research and cultural and scientific mediation by removing all the obstacles identified.

4.1 Description of the Consortium

In May 2024, the Ikigai - Games for Citizens consortium brought together 17 universities, 6 Grandes Ecoles, the three major French national players in digital higher education, research laboratories, associations and institutions (Games for Citizens, 2024). The consortium is involved in a number of research and content production projects for various higher education and continuing education institutions.

With the support of three French ministries (Ministère de l'Education nationale, et de la jeunesse; Ministère de la Culture; Ministère de l'enseignement supérieur et de la recherche), the more than 40 members are working in partnership to use video games for learning and mediation in the general interest, on a variety of themes and for different audiences.

4.2 Pooling of Resources Between Partners

The central element around which the pooling of resources is built lies in the recruitment of a team known as the "Frame": this brings together a group of video game professionals as well as a range of professions relating to the technical structuring of the web, AI and data sciences, communication, training and the administration of a national consortium. By pooling human resources, each of the association's partners not only participates in the emergence of new joint projects, but also benefits from a significant amount of work time on its own projects that the core team can dedicate to it, at an optimised cost.

In support of this approach, and to bring pooling to its optimum, all the resources produced for the games, all their building blocks, can be reused for other games developed for all the members of the consortium. This pooling allows development costs to be optimised and investment to be sustained over time, authorises the re-use of common elements, but also guarantees the possibility of improvements and continuous innovation through control of the sources and the permanent availability of a team of specialists. Over the years, the studio has built up a wealth of expertise, as well as a digital capital consisting of a catalog of learning and educational video games that is constantly being expanded.

4.3 Co-design by Teaching Teams and Video Game Specialists

The team of video game professionals at Ikigai - Games for Citizens has developed a methodology that involves co-developing each project with the teaching and educational teams of the partner organisations. By systematising procedural rhetoric (Bogost, 2008), its game design principles include reflection on the situations that lead players to engage in meaningful activities from a learning perspective.

This dual approach to games and teaching means that the products are designed to meet the expectations of identified audiences as closely as possible: players, as well as teachers and trainers. To satisfy these two targets, the fun approach is chosen in consultation with the educational objectives and the context of use of the game for the defined audience.

Finally, the game must be produced in line with the standards of the videogame market and meet the expectations of a demanding audience with a videogame culture that needs to be taken into account.

4.4 Co-Distribution

Among the obstacles identified, the visibility of the final production was a key factor. If the game created is perfectly produced, it is a shame that it is not widely distributed and promoted in line with the human, technical and financial investment made. On the basis of these considerations, the members of the consortium decided to create a common distribution platform: a reference portal where all the members' creations would be

distributed, but which could also host the members' past productions or games created elsewhere that are of educational and entertaining interest to the public.

This reference portal (Ikigai, 2024) is now online and is constantly being enriched with new content, distributed free of charge and without advertising, for the widest possible audience, beyond the first circle of initial and continuing education institutions.

For the members of the consortium, the implementation of this type of platform on a national scale also enables the deployment of services associated with the games on an unprecedented scale: a set of data linked to the use of the games is constantly extracted, in compliance with the GDPR, enabling teachers to monitor training and the creation and distribution of customised content, as well as creating an unprecedented volume of data for research into teaching through video games.

4.5 Open to Research

The collection of data on the use of games, made possible by the medium of video games, is also a valuable resource for measuring the impact of a game-based educational tool. A large volume of data can be identified, such as the time spent on a game, per game session, learning effectiveness, user audiences, etc.

The diversity and quantity of this data will enable a whole range of research into digital education, game-based education and Artificial Intelligence for education (see part 5).

Ikigai's Scientific Advisory Board, made up of around thirty researchers from among its members, is piloting research into gamification. The areas studied cover a wide range of issues relating to game-based education, from practical implementation to indicators for evaluation. The Scientific Advisory Board also acts as an ethics committee within the consortium, guaranteeing compliance with GRPD and promoting ethics in research in this field and in the use of its findings.

Respect for private data has led the Ikigai - Games for Citizens consortium to deploy an Edge computing network structure (Sulema et al, 2023). Players' personal data (if they are connected to their account) is only hosted within their training establishment. Outside their institution, this data remains inaccessible in its current state: only statistical results and analyses carried out on this data can be transmitted to the outside world.

Data is stored in Learning Record Stores (LRS) using the xAPI format. Each training establishment has a Data Processing Unit (DPU), possibly a cluster of machines, which is capable of analysing local data as well as liaising with DPUs on other sites to request data processing.

A software layer (API) enables the data to be processed locally, without any transmission to the outside world, thereby ensuring the confidentiality of the data by only allowing the transmission of aggregated results between the DPUs, the results of processing a set of individual items of information. This type of architecture, considered as an edge computing scheme, can be extended on a large scale over time and makes it possible to optimise research work in terms of the volume of processed/treatable data, confidentiality and network traffic.

As the xAPI ecosystem is very flexible, a hierarchy of xAPI declarations had to be designed in order to define a set of metadata declarations related to the use of a game ranging from global concerns (meta-analysis) to concerns specific to certain user activities in a given game (Sulema et al, 2023): thus, for example, data such as the number of games started can be counted (global data) regardless of the type of game, but also the number of puzzles completed for games linked to challenges (data specific to a category of game). These declarations enable analyses and research with different meta-analysis granularities for the widest possible diversity of games at each level of scale chosen for an analysis.

Finally, to ensure that it is possible to work with data collected as widely as possible, the consortium is involved in the European Promotheus-X project (Promotheus-X, 2024), which aims to define interoperable data formats between the services that produce them and those that use them in the field of education.

5. Video Games, a Gateway to Lifelong Learning of Tomorrow

By its nature, video games make it possible to create data on learning and the use of games in education. By the way it is structured, the Ikigai - Games for Citizens consortium network makes it possible to collect this data on a national scale and beyond. The combination of these elements means that there are benefits for all users: the scientific community obtains a set of data unequalled in number and quality for conducting research. This research will make it possible to establish a new, fairer and more effective model for user training (De Clercq,

2023): personalised pathways, centered on the user him/herself, with pedagogical recommendations enabling continuous training throughout the learner's life.

5.1 Use of AI Made Possible by Structuring

Ikigai's national network infrastructure can collect a sufficient volume of data to train a Machine Learning algorithm in a federative learning mode. Several models will be trained to improve the user experience and enable the creation of enriched personalised profiles to provide better support for learners.

For example, these AIs will be able to detect a student's shortcomings in real time and offer them a set of personalised recommendations to help them achieve the objectives defined by the course. This same information, transmitted to a teaching team, will enable precise monitoring of learning and better support for learners.

On the research side, trained AIs will be capable of analysing personal and collective dynamics during educational activities, enabling the subsequent improvement and creation of new algorithms specialising in education.

5.2 Serving the Training Needs of all

Using the data collected and the power of the algorithms and AIs integrated into Ikigai's national network, a range of services will eventually be available to training establishments and their learners, whatever their initial or continuing training course, ensuring the possibility of personalised courses throughout life.

Learners will be presented with a video game that can be used to develop an educational course for personalised skills enhancement. Learners' difficulties and errors will be identified. A possible drop-out or lack of commitment will be detected, as will the repetition of errors that at first seem innocuous, but which may point to cognitive dissonance or skills that have not yet been acquired.

This set of elements will enable teachers to make the most of the time they have with their learners by enriching their exchanges and offering content that is perfectly suited to the needs of each individual.

5.3 Skills-based Approach

Individualised support requires the construction of skills-based educational databases. When solving a complex task or problem, learners need to call on a range of different skills, sometimes simultaneously.

By collecting user traces (Sulema et al., 2023), it becomes possible to isolate and assess these skills to obtain a personalised portfolio of the learner's skills. At the same time, this advance enables teaching to evolve towards a skills-based approach, co-constructed with teachers.

Building on the MEMORAe project (Abel, 2021), Ikigai and its partners are investigating the use of interactive skills map concepts enabling teachers to describe their teaching unit in the form of a skills tree. The map provides a new data structure for analysing skills acquired or being acquired for individualised support, reconfiguring the approach to learner training.

6. Conclusion

While games and video games are particularly rich tools for learning, whether for learners or teachers, access to this type of medium is not easy. It was with this in mind that the members of the Ikigai - Games for Citizens consortium came together.

Together, they have decided to tackle a series of challenges to ensure that the deployment of video games in education is possible beyond a few isolated cases that act more as demonstrators than everyday tools for educators: a structural challenge at the political level to move towards pooling resources, and a structural challenge at the hardware level to deploy a coherent and efficient network.

By using video games to mobilise commitment, convey knowledge and create data, they are together proposing a new educational approach that will enable individual learners to flourish through the continuous improvement of the resources available to them. Drawing on scientific research in the humanities and social sciences, educational sciences, cognitive sciences and artificial intelligence, the results of the consortium's experiments

will provide learners from all backgrounds with individualised support and more efficient learning in their initial or continuing education.

References

Abel, M.-H. (2021) MEMORAe project: an approach and a platform for learning innovation, *Multimedia Tools and Applications*, 81. 1-15. 10.1007/s11042-021-11157-8.

Bandura, A. (2009). La théorie sociale cognitive : une perspective agentique. *Traité de psychologie de la motivation: Théories et pratiques* (pp. 15-45). Paris: Dunod. https://doi.org/10.3917/dunod.carre.2009.01.0015

Barnabé, F. & Delbouille J. (2018) Aux frontières de la fiction : l'avatar comme opérateur de réflexivité », *Sciences du jeu* [En ligne], 9 | 2018, mis en ligne le 01 juin 2018, consulté le 30 avril 2024. URL : http://journals.openedition.org/sdj/958 ; DOI : https://doi.org/10.4000/sdj.958

Bayeck, R. Y. (2020). Examining Board Gameplay and Learning: A Multidisciplinary Review of Recent Research. Simulation & Gaming, 51(4), 411-431. https://doi.org/10.1177/1046878119901286

Bogost, I. (2008) The Rhetoric of Video Games, in The Ecology of Games: Connecting Youth, Games, and Learning, *The John D. and Catherine T. MacArthur Foundation Series on Digital Media and Learning. Cambridge*, MA: The MIT Press. 117–140.
doi: 10.1162/dmal.9780262693646.117

Brown, E. (2004) A grounded investigation of game immersion, Conference on Human Factors in Computing Systems - Proceedings. 1297-1300. 10.1145/985921.986048.

De Clercq, M. (2023). Les défis de l'enseignement supérieur : Entre accessibilité, équité et réussite. Diversité. *Revue d'actualité et de réflexion sur l'action éducative*, (202, 1). https://publications-prairial.fr/diversite/index.php?id=3808

Eco, U. (1962) *Opera aperta. Forma e indeterminazione nelle poetiche contemporanee*, Milan, Bompiani

Games for Citizens (2024) *Ikigai - Games for Citizens,* Available at: https://www.gfc.ikigai.games/ (Accessed: 24 April 2024)

Gee J.P. (2003) *What Video Games Have to Teach us About Learning and Literacy*, Palgrove Macmillan, Basingstoke.

Genvo, S. (2008) Caractériser l'expérience du jeu à son ère numérique : pour une étude du "play design", Journée d'études Les jeux vidéo : expériences et pratiques sociales multidimensionnelles, Québec, Canada, 6 et 7 mai, disponible en ligne : http://www.ludologique.com/wordpress/?p=105

Huizinga, J. (1938) *Homo Ludens. Essai sur la fonction sociale du jeu*, trad. du néerlandais par C. Seresia, Paris, Gallimard, 1951

Ikigai (2024) *Bienvenue sur Ikigai, votre service d'intérêt général pour se cultiver par le jeu*. Available at: https://ikigai.games. (Accessed: 24 April 2024)

Maldonado, L. (2024) L'engagement narratif dans les jeux vidéo en tant qu'engagement d'apprentissage, *Sciences du jeu* [En ligne], 20-21 | 2023, mis en ligne le 14 décembre 2023, consulté le 24 avril 2024. URL : http://journals.openedition.org/sdj/5821 ; DOI : https://doi.org/10.4000/sdj.5821

Promotheus-X (2024) *Welcome to the future of Data Spaces in Europe.* Available at: https://prometheus-x.org/ (Accessed: 24 April 2024)

Sanchez, E. & Romero, M. (2020) *Apprendre en jouant*. Paris : Retz, 2020, 141 p.

Sanchez, E (2023) *Enseigner et former avec le jeu - Développer l'autonomie, la confiance et la créativité avec des pratiques pédagogiques innovantes*. ESF Sciences humaines.

Sauvé, L., Renaud, L. & Gauvin, M. (2007). Une analyse des écrits sur les impacts du jeu sur l'apprentissage. *Revue des sciences de l'éducation*, 33(1), 89-107. https://doi.org/10.7202/016190ar

SELL (2023) *Étude "Les Français et le jeu vidéo"*. Available at: https://afjv.link/file_server/afjv_download/2023/231019_les_francais_et_le_jeu_video_oct_2023.pdf (Accessed: 24 April 2024)

Sulema, Y., Pester, A., Laforge, B., & Andres, F. (2023) *Augmented Reality User's Experience: AI-Based Data Collection, Processing and Analysis*, In *Augmented Reality and Artificial Intelligence: The Fusion of Advanced Technologies* (pp. 31-46). Cham: Springer Nature Switzerland

Viau, R. (1999) *La motivation dans l'apprentissage du français*. St-Laurent (Québec) : Éditions du Renouveau Pédagogique

Wigfield, A. & Wentzel, K. R. (2007) Introduction to motivation at school: Interventions that work. *Educational Psychologist*, 42(4), 191–196. https://doi.org/10.1080/00461520701621038